IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of: **Shannon, et al.**	§	Serial No.: **10/823,371**
	§	
Filed: **April 12, 2004**	§	Confirmation No.: **4850**
	§	
Docket No.: **8824/ETCH/DRIE**	§	Group Art Unit: **1792**
	§	
	§	Examiner: **Arancibia, Maureen G.**
	§	
For: **DUAL FREQUENCY RF MATCH**	§	
	§	

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

APPEAL BRIEF

Appellants submit this Appeal Brief to the Board of Patent Appeals and Interferences on appeal from the decision of the Examiner of Group Art Unit 1792 dated April 1, 2008, finally rejecting claims 1, 3-10, and 12-21 of the present invention.

The Appellants believe that a $510 Appeal Brief fee is due in connection with this response. The Commissioner is hereby authorized to charge counsel's Deposit Account No. 50-3562 for this fee, and for any other fees, including extension of time fees, required to make this response timely and acceptable to the Office.

REAL PARTY IN INTEREST

The real party in interest is Applied Materials, Inc., located in Santa Clara, California.

RELATED APPEALS AND INTERFERENCES

The Appellants know of no related appeal and/or interference that may directly affect or be directly effected by or have a bearing on the Board's decision in the pending appeal.

STATUS OF CLAIMS

Claims 1, 3-10, and 12-21 are pending in the application. Claims 2 and 11 have been cancelled. Claims 1, 3-10, and 12-21 stand rejected as discussed below. All rejections of claims 1, 31-, and 12-21 as set forth in the Final Office Action dated April 1, 2008, and as noted below, are appealed. The pending appealed claims are shown in the attached Appendix.

STATUS OF AMENDMENTS

All claim amendments have been entered by the Examiner. No amendments to the claims were proposed after the final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

Embodiments of the present invention relate to match circuits for coupling two RF signals to an electrode in a plasma enhanced semiconductor processing chamber. In embodiments corresponding to independent claim 1, an apparatus (108) for matching the impedance of a pair of RF sources (104, 106) coupled to a single electrode (110) to the impedance of a plasma in a semiconductor substrate processing chamber (100) includes a first sub-circuit (202) for matching the impedance of a first variable frequency RF signal generated by a first RF source to the impedance of the plasma; and a second sub-circuit (204) for matching the impedance of a second variable frequency RF signal generated by a second RF source to the impedance of the plasma, the second sub-circuit connected to the first sub-circuit to form a common output (212) that is coupled to the electrode; wherein the first and second sub-circuits each further comprise at least

one fixed set of series components (*e.g.*, L_1, C_2, or L_2, C_3) and at least one variable shunt component (*e.g.*, C_1 or C_4) connected to ground, and wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit. (*Specification*, ¶¶ [0014-0016] discussing Fig. 1; ¶¶ [0017] and [0019] discussing Fig. 2; and ¶¶ [0020]-[0021] discussing Fig. 3.)

In embodiments corresponding to independent claim 9, an apparatus (108) for matching the impedance of a pair of RF sources (104, 106) coupled to a single electrode (110) to the impedance of a plasma in a semiconductor substrate processing chamber (100) includes a first sub-circuit (202) for coupling to a first variable frequency RF source and having a first set of fixed series components (*e.g.*, L_1, C_2) and a first variable shunt to ground (*e.g.*, C_1); and a second sub-circuit for coupling to a second variable frequency RF source and having a second set of fixed series components (*e.g.*, L_2, C_3) and a second variable shunt to ground (*e.g.*, C_4), the second sub-circuit connected to the first sub-circuit to form a common output (212) that is coupled to the electrode; wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit. (*Specification*, ¶¶ [0014-0016] discussing Fig. 1; ¶¶ [0017] and [0019] discussing Fig. 2; and ¶¶ [0020]-[0021] discussing Fig. 3.)

In embodiments corresponding to independent claim 10, an apparatus (108) for matching the impedance of a pair of RF sources (104, 106) coupled to a single electrode (110) to the impedance of a plasma in a semiconductor substrate processing chamber (100) includes a processing chamber (100) comprising at least a first electrode (110); a first variable frequency RF source (104); a second variable frequency RF source (106); and a dual frequency matching circuit (108), comprising: a first sub-circuit (202) coupled to the first RF source; and a second sub-circuit (204) coupled to the second RF source and connected to the first sub-circuit to form a common output (212) that is coupled to the first electrode; wherein the first and second sub-circuits each further comprise at least one fixed set of series components (*e.g.*, L_1, C_2, or L_2, C_3) and at least one variable shunt component (*e.g.*, C_1 or C_4) connected to ground, and wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit. (*Specification*,

¶¶ [0014-0016] discussing Fig. 1; ¶¶ [0017] and [0019] discussing Fig. 2; and ¶¶ [0020]-[0021] discussing Fig. 3.)

In embodiments corresponding to independent claim 19, an apparatus (108) for matching the impedance of a pair of RF sources (104, 106) coupled to a single electrode (110) to the impedance of a plasma in a semiconductor substrate processing chamber (100) includes a first sub-circuit (202) for matching the impedance of a first RF signal having a variable frequency of between about 50 KHz and about 14.2 MHz generated by a first RF source to the impedance of the plasma; and a second sub-circuit (204) for matching the impedance of a second RF signal having a variable frequency of between about 50 KHz and about 14.2 MHz generated by a second RF source to the impedance of the plasma, the second sub-circuit connected to the first sub-circuit to form a common output (212) that is coupled to the electrode, and wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit. (*Specification*, ¶¶ [0014-0016] discussing Fig. 1; ¶¶ [0017] and [0019] discussing Fig. 2; and ¶¶ [0020]-[0021] discussing Fig. 3.)

In embodiments corresponding to independent claim 21, an apparatus (108) for matching the impedance of a pair of RF sources (104, 106) coupled to a single electrode (110) to the impedance of a plasma in a semiconductor substrate processing chamber (100) includes a first sub-circuit (202) for matching the impedance of a first RF signal generated by a first RF source to the impedance of the plasma; and a second sub-circuit (204) for matching the impedance of a second RF signal generated by a second RF source to the impedance of the plasma, the second sub-circuit connected to the first sub-circuit to form a common output (21) that is coupled to the electrode; wherein the first and second sub-circuits are each adapted to vary a respective match tune space defined by the respective sub-circuit without affecting another respective match tune space defined by the other sub-circuit. (*Specification*, ¶¶ [0014-0016] discussing Fig. 1; ¶¶ [0017] and [0019] discussing Fig. 2; and ¶¶ [0020]-[0021] discussing Fig. 3.)

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1, 3, 4, 6, 7, 9, 10, 12-15 and 17-21 stand rejected under 35 USC. §103(a) as being unpatentable over Japanese Application Publication No. 08-097199A, published April 12, 1996 to *Nishiyama et al.* (hereinafter *Nishiyama*) in view of Japanese Patent Application Publication No 06-243992, published September 2, 1994 to *Deguchi, et al.* (hereinafter *Deguchi*).

2. Claim 5 stands rejected under 35 USC §103(a) as being unpatentable over *Nishiyama* in view of *Deguchi* as applied to Claim 1 above, and further in view of US Patent No. 6,887,339, issued May 3, 2005, to *Goodman, et al.* (hereinafter *Goodman*).

3. Claims 8 and 16 stand rejected under 35 USC §103(a) as being unpatentable over *Nishiyama* in view of *Deguchi* as applied to Claims 1 and 10 above, and further in view of US Patent No. 6,641,149, issued November 4, 2003, to *Suemasa, et al.* (hereinafter *Suemasa*).

ARGUMENT

CLAIM REJECTIONS

A. 35 USC §103 Claims 1, 3, 4, 6, 7, 9, 10, 12-15 and 17-21

Claims 1, 3, 4, 6, 7, 9, 10, 12-15 and 17-21 stand rejected under 35 USC. §103(a) as being unpatentable over *Nishiyama* in view of *Deguchi*. The Appellants respectfully disagree.

Independent claims 1, 9, 10, and 19 each recite limitations not taught or suggested by any permissible combination of *Nishiyma* and *Deguchi*.

Nishiyama generally teaches a method for forming an insulation layer using a plasma enhanced chemical vapor deposition apparatus. (See, *Nishiyama*, English Machine Translation (EMT), pg. 1, ¶ [0001].) With respect to the apparatus, *Nishiyama* discloses a counterelectrode 15 that is equipped with RF generators 16 and 17 of two variable frequencies through two independent matching networks 18 and 19, respectively. (*Id*. at ¶ [0012].) However, and as admitted by the Examiner, *Nishiyama* fails to teach or suggest, an apparatus for matching the impedance of a pair of RF sources wherein a first match tune space defined by a first sub-circuit can be varied

without affecting a second match tune space defined by a second sub-circuit, as recited in claims 1, 9, 10, and 19.

Deguchi teaches a plasma processing device having a matching part 14 and an RF electric power supply part 12 in which the impedance is matched by changing an oscillation frequency of output electric power on the side of the RF electric power supply part 12. *Deguchi*, however, discloses only one RF signal for one matching part and is devoid of any teaching or suggestion regarding the matching of multiple RF signals fed to a single electrode. Specifically, *Deguchi* fails to teach or suggest an apparatus for matching the impedance of a pair of RF sources coupled to a single electrode to the impedance of a plasma in a semiconductor substrate processing chamber wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit, as recited in independent claims 1, 9, 10, and 19. The Examiner appears to agree with the above and relies upon *Deguchi* merely for teaching that the matching apparatus may be operated by changing an oscillation frequency of output electric power on the side of the RF electric power supply part 12.

Therefore, *Deguchi* fails to teach or suggest a modification of *Nishiyama* that would yield an apparatus for matching the impedance of a pair of RF sources wherein a first match tune space defined by a first sub-circuit can be varied without affecting a second match tune space defined by a second sub-circuit, as recited in claims 1, 9, 10, and 19. Thus, a *prima facie* case of obviousness has not been established as the combination of the cited art fails to yield the limitations recited in the claims.

As noted in prior Office Action responses and as acknowledged by the Examiner in the Final Office Action dated April 1, 2008, it is well settled law that structural elements may be defined functionally. "A patent applicant is free to recite features of an apparatus either structurally or functionally." (*In re Schreiber*, 128 F.3d 1473, 44 USPQ 2d 1429 (Fed. Cir. 1997).) "[T]here is nothing intrinsically wrong with [defining something by what it does rather than what it is] in drafting patent claims." (*In re Swinehart*, 439 F.2d 210, 212, 169 USPQ 226, 228 (CCPA 1971).) "[W]hile the claims contain numerous functional statements, these statements seem to be for the purpose of clearly defining or differentiating elements which have been positively included in the

claims. We see no objection to the use of functional statements to define an element…." *In re Sherman*, 45 USPQ 532, 534 (Pat. Off. App. 1939).)

Here, as noted above as held by the courts to be permissible, any functional statements present in the independent claims are "for the purpose of clearly defining or differentiating elements which have been positively included in the claims" (*e.g.*, the first and second sub-circuits). These "functional" limitations impose a structural difference between the present claims and the combination of cited art asserted by the Examiner. Specifically, the first sub-circuit must have a structure that allows a first match tune space defined by the first sub-circuit to be varied without affecting a second match tune space defined by the second sub-circuit. This structure is neither taught nor suggested by the cited art.

The Examiner asserts that the apparatus taught by the combination of *Nishiyama* and *Deguchi* meets "all of the structural limitations of the claimed invention" and "would be structurally capable of performing the intended use of allowing the first match tune space defined by the first sub-circuit to be varied without substantially affecting the second match tune space defined by the second sub-circuit, by varying the shunt capacitors." (*Final Office Action* dated April 1, 2008, p. 4-5.)

However, the Appellants note that neither *Nishiyama* nor *Deguchi* teach or suggest that "the first match tune space defined by the first sub-circuit to be varied without substantially affecting the second match tune space defined by the second sub-circuit, by varying the shunt capacitors," as asserted by the Examiner. The Examiner appears to acknowledge this and relies solely upon the Appellants' own disclosure to support her assertion.

For example, in the Response to Arguments section of the Final Office Action dated April 1, 2008, the Examiner maintains her reliance upon her asserted reasoning to show that the structure taught by the combination of *Nishiyama* and *Deguchi* would be structurally capable of performing the function recited in the claims of allowing the first match tune space defined by the first sub-circuit to be varied without substantially affecting the second match tune space defined by the second sub-circuit by varying the variable shunt capacitor. (*Id.*, p. 9, emphasis added by the Examiner.)

However, no piece of cited art nor other line of reasoning (other than reliance upon the Appellants' specification as discussed below) is provided by the Examiner to support this conclusory assertion. Instead, the Examiner only refers to paragraphs 20 and 21 of the present application to provide the reasoning for her assertion. (*Id.*) However, the Appellants' own teachings with respect to the operation of the presently claimed invention does not show how any supposed combination of *Nishiyama* and *Deguchi* may operate. Specifically, the present application discusses the benefits of the present invention and not of any alleged combinations of other match circuits. As such, the operation of the present invention sheds no light on what would happen were one to combine the cited art in the manner asserted by the Examiner, then operate it in a manner as discussed in the present application.

The Examiner appears to be taking the position that any match circuit having fixed series components and variable shunts to ground would be "structurally capable" of the tune space independence obtained by the present invention. The Appellants strongly disagree with this position and note that there is no support in the record for such a position.

Firstly, as noted above, the Examiner's reliance on the present specification goes too far, as the specification does not provide such a teaching. Moreover, the Declaration of inventor Steven S. Shannon, filed September 27, 2007 (Copy attached as E1 in Evidence Appendix; discussed in previous Office Action responses and below), shows that only some match circuits having fixed series elements and variable shunt capacitors of a dual frequency match circuit can provide respective tune space independence. For example, paragraph 10 of the declaration notes that a first match circuit in accordance with the limitations claimed herein does not result in a tune space shift when varying the shunt capacitor, but that a second match circuit, not in accordance with the limitations claimed herein, does result in a tune space shift when varying the shunt capacitor. Thus, consistent with the Appellants position, and contrary to the Examiner's reliance on the present application, there is no evidence in either the Appellants' application or in the cited art, that the combination of the cited art fails to yield the limitations of the claims. As such, merely providing the match circuits of *Nishiyama* with fixed series components and a variable shunt to ground of *Deguchi* fails

to teach, suggest, or otherwise yield a match circuit having a structure having tune space independence for the respective tuning circuits for each frequency signal.

In the Response to Arguments section of the Final Office Action dated April 1, 2008, the Examiner contends that the Declaration is insufficient to show that the combination of *Nishiyama* and *Deguchi* fails to teach or suggest the claimed invention. Specifically, the Examiner asserts that the rejection is based on structural capability of the apparatus formed from the combination of *Nishiyama* and *Deguchi* to perform in the same manner as the claimed invention, based on user control of the variable shunt capacitors and the variable RF sources (*Final Office Action* dated April 1, 2008, p. 11, emphasis added by the Examiner) and that the Declaration is silent as to why the apparatus formed from the combination of *Nishiyama* and *Deguchi* would not be structurally capable of exhibiting the respective tune space independence of the claimed invention. (*Id.*, p. 11-12, emphasis added by the Examiner.)

However, the Appellants respectfully submit that, as discussed above, the Examiner has not shown that the asserted combination possesses the alleged structure. In addition, the declaration submitted by the Appellants clearly shows that merely combining the references in the manner shown will not necessarily result in a structure that is capable of meeting the limitations recited in the present claims. As such, the Examiner's insistence that the rejection is based upon the structural capability of the apparatus formed by the combination of *Nishiyama* and *Deguchi* is clearly not supported by the cited art or any other line of reasoning.

Furthermore, with respect to user control of the resultant combined apparatus of *Nishiyama* and *Deguchi*, there is no evidence that such user control of the combined apparatus could provide the respective tune space independence as recited in the claims. Moreover, the Appellants direct the Examiner's attention to paragraph 10 of the Declaration, referred to above, that specifically states that such user control of a match circuit having fixed series components and a variable shunt to ground that does not have a structure in accordance with the principles of the present invention, will result in a tune space shift when varying the shunt capacitor – and therefore, is not structurally capable of meeting the limitations recited in the present claims.

The Appellants maintain that it remains the Examiner's burden to show that the combination of cited art will necessarily result in tune space independence, or that it would be obvious to further modify the cited art to do so. Here, the Declaration submitted to the Examiner is clearly sufficient to show that the combination of *Nishiyama* and *Deguchi* proposed by the Examiner fails to teach or suggest the claimed invention because no such teaching, suggestion, or other line of reasoning is provided to overcome the fact that not all match circuits having fixed series components and variable shunts to ground will provide tune space independence, as required by the present claims. Thus, contrary to the assumption of the Examiner, the Declaration shows that simply providing fixed series elements and variable shunt capacitors in a dual frequency match circuit will not necessarily provide respective tune space independence, as recited in the independent claims.

Thus, the Appellants submit that the Declaration is both relevant and sufficient to show that the combination of *Nishiyama* and *Deguchi* fail to teach, suggest, or otherwise yield an apparatus for matching the impedance of a pair of RF sources wherein a first match tune space defined by a first sub-circuit can be varied without affecting a second match tune space defined by a second sub-circuit.

The Examiner further asserts that she is unable to identify any structural difference between the combination of *Nishiyama* and Deguchi and the claimed invention that would prevent the structural capability of *Nishiyama* and *Deguchi* from performing the same functions as the claimed invention. (*Id.*, p. 12.) However, the Appellants counter that the Examiner has not provided any citation or reasoning, other than the Appellants own disclosure, as to why the alleged combination of *Nishiyama* and *Deguchi* would be able to meet the limitations recited in the claims. As the Appellants have already shown why the Appellants' own disclosure does not show that the combination of *Nishiyama* and *Deguchi* would be able to meet the limitations of the claims, and as the Declaration shows that merely providing fixed series elements and a variable shunt to ground will not inherently produce a structural capability to meet the limitations recited in the claims, the Appellants thus submit that the burden of establishing a *prima facie* case of obviousness has not been met. Specifically, for the reasons discussed above, a *prima facie* case has not been established because the

Examiner has not shown that the proposed combination of cited art would yield a match circuit having the structural capability to provide tune space independence as recited in the independent claims.

Thus, the combination of *Nishiyama* and *Deguchi* fails to teach, suggest, or otherwise yield an apparatus for matching the impedance of a pair of RF sources wherein a first match tune space defined by a first sub-circuit can be varied without affecting a second match tune space defined by a second sub-circuit, as recited in claims 1, 9, 10, 19, and 21. Therefore, a *prima facie* case of obviousness has not been established because the combination of *Nishiyama* and *Deguchi* fails to teach or suggest the limitations recited in independent claims 1, 9, 10, 19, and 21.

Thus, claims 1, 9, 10, 19, and 21, and all claims depending therefrom, are patentable over *Nishiyama* in view of *Deguchi*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

B. 35 USC §103 Claim 5

Claim 5 stands rejected under 35 USC §103(a) as being unpatentable over *Nishiyama* in view of *Deguchi* as applied to Claim 1 above, and further in view of *Goodman*. The Appellants respectfully disagree.

Independent claim 1, from which the above rejected claim depends, recites limitations not taught or suggested by any combination of the cited references. The patentability of claim 1 over the combination of *Nishiyama* and *Deguchi* has been discussed above.

The Examiner cites *Goodman* to show that RF sources conventionally have a 50 Ohm output impedance. *Goodman*, however, individually or in any permissible combination with *Nishiyama* and *Deguchi* does not teach or suggest a first sub-circuit for matching the impedance of a first variable frequency RF signal generated by a first RF source to the impedance of the plasma and a second sub-circuit for matching the impedance of a second variable frequency RF signal generated by a second RF source to the impedance of the plasma… wherein the first and second sub-circuits each further comprise at least one fixed set of series components and at least one variable shunt component connected to ground, and wherein a first match tune space defined by the

first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit. Accordingly, the teachings of *Goodman* cannot be used to modify the teachings of *Nishiyama* and *Deguchi* in a manner that yields the limitations as recited in claim 1. Therefore, a *prima facie* case of obviousness has not been established because the combination of *Nishiyama*, *Deguchi*, and *Goodman* fails to teach or suggest the limitations recited in claim 1.

Thus, claim 5 is patentable over *Nishiyama* in view of *Deguchi*, and further in view of *Goodman*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claim allowed.

C. 35 USC §103 Claims 8 and 16

Claims 8 and 16 stands rejected under 35 USC §103(a) as being unpatentable over *Nishiyama* in view of *Deguchi* as applied to Claims 1 and 10 above, and further in view of *Suemasa*. The Appellants respectfully disagree.

Independent claims 1 and 10, from which the above rejected claims respectively depend, recite limitations not taught or suggested by any combination of the cited references. The patentability of claims 1 and 10 over *Nishiyama* and *Deguchi* has been discussed above.

Suemasa teaches a plasma processing method including a process chamber having two RF power sources 122, 128, coupled through two matching devices 120, 126, to a lower electrode 106. (See, *Suemasa* Fig. 1 and accompanying text.) *Suemasa*, however, individually or in any permissible combination with *Nishiyama* and *Deguchi* fails to teach or suggest a first sub-circuit for matching the impedance of a first variable frequency RF signal generated by a first RF source to the impedance of the plasma and a second sub-circuit for matching the impedance of a second variable frequency RF signal generated by a second RF source to the impedance of the plasma… wherein the first and second sub-circuits each further comprise at least one fixed set of series components and at least one variable shunt component connected to ground, and wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit. Accordingly, the teachings of *Suemasa* cannot be used to modify the teachings of

Nishiyama and *Deguchi* in a manner that yields the limitations as recited in claims 1 and 10. Therefore, a *prima facie* case of obviousness has not been established because the combination of *Nishiyama*, *Deguchi* and *Suemasa* fails to teach or suggest the limitations recited in claims 1 and 10.

Thus, claims 8 and 16 are patentable over *Nishiyama* in view of *Deguchi*, and further in view of *Suemasa*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

CONCLUSION

For the reasons advanced above, Appellants respectfully urge that the rejections of claims 1, 3-10, and 12-21 as being unpatentable under 35 U.S.C. §103 are improper. Reversal of the rejections in this appeal, and allowance of all pending claims, is respectfully requested.

Respectfully submitted,

September 2, 2008

/ Alan Taboada /
Alan Taboada
Attorney Reg. No. 51,359
(732) 935-7100

Moser IP Law Group
1030 Broad Street, 2nd Floor
Shrewsbury, NJ 07702

CLAIMS APPENDIX

1. (Previously Presented) Apparatus for matching the impedance of a pair of RF sources coupled to a single electrode to the impedance of a plasma in a semiconductor substrate processing chamber, comprising:

a first sub-circuit for matching the impedance of a first variable frequency RF signal generated by a first RF source to the impedance of the plasma; and

a second sub-circuit for matching the impedance of a second variable frequency RF signal generated by a second RF source to the impedance of the plasma, the second sub-circuit connected to the first sub-circuit to form a common output that is coupled to the electrode;

wherein the first and second sub-circuits each further comprise at least one fixed set of series components and at least one variable shunt component connected to ground, and wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit.

2. (Cancelled)

3. (Previously Presented) The apparatus of claim 1, wherein a match tune space of the first and second RF sources is controllable by the shunt components.

4. (Previously Presented) The apparatus of claim 1, wherein a match tune space of the first and second RF sources is controllable by varying at least one of a first and a second frequency of a signal respectively generated by the first and second RF sources.

5. (Original) The apparatus of claim 1, wherein the first and second RF sources each have a 50 Ohm output impedance.

6. (Original) The apparatus of claim 1, wherein the first and second sub-circuits are fixed in a predetermined configuration prior to performing a particular process in the processing chamber.

7. (Original) The apparatus of claim 1, wherein the impedance of the first and second RF sources may be matched to the impedance of the processing chamber during processing by at least one of:

varying at least one value of a component of the first and second sub-circuits during operation of the processing chamber; or

varying the frequency of at least one of the first and the second RF sources.

8. (Original) The apparatus of claim 1, further comprising:

an isolation sub-circuit for preventing power supplied from either of the first and second RF sources from being coupled to the other of the first and second RF sources.

9. (Previously Presented) Apparatus for matching the impedance of a pair of RF sources coupled to a single electrode to the impedance of a plasma in a semiconductor substrate processing chamber, comprising:

a first sub-circuit for coupling to a first variable frequency RF source and having a first set of fixed series components and a first variable shunt to ground; and

a second sub-circuit for coupling to a second variable frequency RF source and having a second set of fixed series components and a second variable shunt to ground, the second sub-circuit connected to the first sub-circuit to form a common output that is coupled to the electrode;

wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit.

10. (Previously Presented) Apparatus for matching the impedance of a pair of RF sources coupled to a single electrode to the impedance of a plasma in a semiconductor substrate processing chamber, comprising:

a processing chamber comprising at least a first electrode;

a first variable frequency RF source;

a second variable frequency RF source; and

a dual frequency matching circuit, comprising:

a first sub-circuit coupled to the first RF source; and

a second sub-circuit coupled to the second RF source and connected to the first sub-circuit to form a common output that is coupled to the first electrode;

wherein the first and second sub-circuits each further comprise at least one fixed set of series components and at least one variable shunt component connected to ground, and wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit.

11. (Cancelled)

12. (Previously Presented) The apparatus of claim 10, wherein a match tune space of the first and second RF sources is controllable by the shunt components.

13. (Previously Presented) The apparatus of claim 10, wherein a match tune space of the first and second RF sources is controllable by varying at least one of a first and a second frequency of a signal respectively generated by the first and second RF sources.

14. (Original) The apparatus of claim 10, wherein the first and second sub-circuits are fixed in a predetermined configuration prior to performing a particular process in the processing chamber.

15. (Previously Presented) The apparatus of claim 10, wherein the impedance of the first and second RF sources may be matched to the impedance of the processing chamber during processing by at least one of:

varying at least one value of a component of the first and second sub-circuits during operation of the processing chamber; or

varying the frequency of at least one of the first and the second RF sources.

16. (Original) The apparatus of claim 10, wherein the dual frequency matching circuit further comprises:

an isolation sub-circuit for preventing power supplied from either of the first and second RF sources from being coupled to the other of the first and second RF sources.

17. (Previously Presented) The apparatus of claim 1, wherein the first sub-circuit and the second sub-circuit are both configured to match the impedance of an RF signal having a frequency of between about 50 KHz and about 14.2 MHz.

18. (Previously Presented) The apparatus of claim 10, wherein the first RF source and the second RF source are both configured to provide an RF signal having a frequency of between about 50 KHz and about 14.2 MHz.

19. (Previously Presented) Apparatus for matching the impedance of a pair of RF sources coupled to a single electrode to the impedance of a plasma in a semiconductor substrate processing chamber, comprising:

a first sub-circuit for matching the impedance of a first RF signal having a variable frequency of between about 50 KHz and about 14.2 MHz generated by a first RF source to the impedance of the plasma; and

a second sub-circuit for matching the impedance of a second RF signal having a variable frequency of between about 50 KHz and about 14.2 MHz generated by a second RF source to the impedance of the plasma, the second sub-circuit connected to the first sub-circuit to form a common output that is coupled to the electrode, and wherein a first match tune space defined by the first sub-circuit can be varied without affecting a second match tune space defined by the second sub-circuit.

20. (Previously Presented) The apparatus of claim 19, wherein the first and second sub-circuits each further comprise:

at least one fixed set of series components; and

at least one variable shunt component connected to ground.

21. (Previously Presented) Apparatus for matching the impedance of a pair of RF sources coupled to a single electrode to the impedance of a plasma in a semiconductor substrate processing chamber, comprising:

a first sub-circuit for matching the impedance of a first RF signal generated by a first RF source to the impedance of the plasma; and

a second sub-circuit for matching the impedance of a second RF signal generated by a second RF source to the impedance of the plasma, the second sub-circuit connected to the first sub-circuit to form a common output that is coupled to the electrode;

wherein the first and second sub-circuits are each adapted to vary a respective match tune space defined by the respective sub-circuit without affecting another respective match tune space defined by the other sub-circuit.

EVIDENCE APPENDIX

E1. Copy of DECLARATION OF STEVEN C. SHANNON UNDER 37 CFR §1.132 filed September 17, 2007 attached hereto.

EVIDENCE APPENDIX E1

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

PATENT APPLICATION

Applicant: **Shannon, et al.** Case: **8824/ETCH/DRIE**

Serial No.: **10/823,371** Filed: **April 12, 2004**

Examiner: **Arancibia, Maureen Gramalgia** Group Art Unit: **1763**

Confirmation No.: **4850**

Title: **DUAL FREQUENCY RF MATCH**

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

S I R:

DECLARATION OF STEVEN C. SHANNON UNDER 37 CFR §1.132

I, Steven C. Shannon, declare as follows:

1. I am citizen of the USA, and I reside at 1501 Trollman Avenue, San Mateo, CA 94401.

2. I graduated in 1995 from University of Michigan in Ann Arbor, MI, with a Bachelor of Science in Engineering degree in Nuclear Engineering; in 1997 from University of Michigan in Ann Arbor, MI, with a Masters of Science in Engineering degree in Nuclear Engineering; and in 1999 from University of Michigan in Ann Arbor, MI, with a Doctor of Philosophy in Engineering degree in Nuclear Engineering.

3. Since 1999, I have been working in the field of low pressure RF plasma discharges for microelectronics fabrication; I have been employed by Applied Materials, Inc., since 1999, and all of this time has been spent in this specialty.

4. Since 2000, I have been acting in the capacity of adjunct faculty at San Jose State University where I have instructed students in materials science and engineering,

EVIDENCE APPENDIX E1

with particular focus on integrated circuit fabrication technology and plasma science. I have been employed by San Jose State University since 2000, and all this time has been spent in this specialty.

5. I have been granted at least 4 US patents in the RF and plasma science field.

6. I am one of the co-inventors of the subject matter described and claimed in the above-identified patent application and I am familiar with the disclosure and pending claims in the above-identified patent application.

7. The disclosure of the above identified application describes a match circuit design for coupling two frequencies to a common electrode that provides a match tune space that can be varied for either frequency input by shunt component tuning without the undesirable side-effect of shifting the other frequency's tune space. Consequently, the first and second frequency's tune spaces may be independently controlled with no interaction in the match circuit.

8. The match circuit design in the present application may have at least one fixed set of series components and at least one variable shunt component connected to ground.

9. Other configurations of match circuit designs for coupling two frequencies to a common electrode and having at least one fixed set of series components and at least one variable shunt component connected to ground may be designed that do not provide a first match tune space that can be varied without affecting a second match tune space. Therefore, fixed series elements in the respective tuning portions of the dual frequency match circuit do not necessarily provide respective tune space independence.

10. As an example, a Smith chart is attached hereto as Exhibit A corresponding to a first match circuit (line 100) according to embodiments of the present invention compared to a second match circuit (lines 102 and 104) having fixed series components and a variable shunt to ground that does not comport with the principles of the present invention. This Smith chart represents an actual model derived from proprietary Applied Materials, Inc. parallel lump element match circuit analysis performed in the MathCAD software package.

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10. The Smith chart shows a tune space graph for the first match circuit (line 100) that overlaps and appears as a single line – corresponding to no shift in one tune space when varying the shunt components of the other tuning portion of the match circuit. The Smith chart further shows a tune space graph for the second match circuit (lines 102 and 104) that clearly diverges – corresponding to a tune space shift for one frequency as a function of the variation of the other frequency's shunt capacitor position. Thus, the first tune space provided by the second match circuit modeled in Exhibit A cannot be varied without affecting the second match tune space provided by the match circuit.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date September 12, 2007

Steven C. Shannon

EVIDENCE APPENDIX E1

Applicant: **Shannon, et al.**
Serial No.: **10/823,371**
Examiner: **Arancibia, Maureen Gramalgia**
Confirmation No.: **4850**

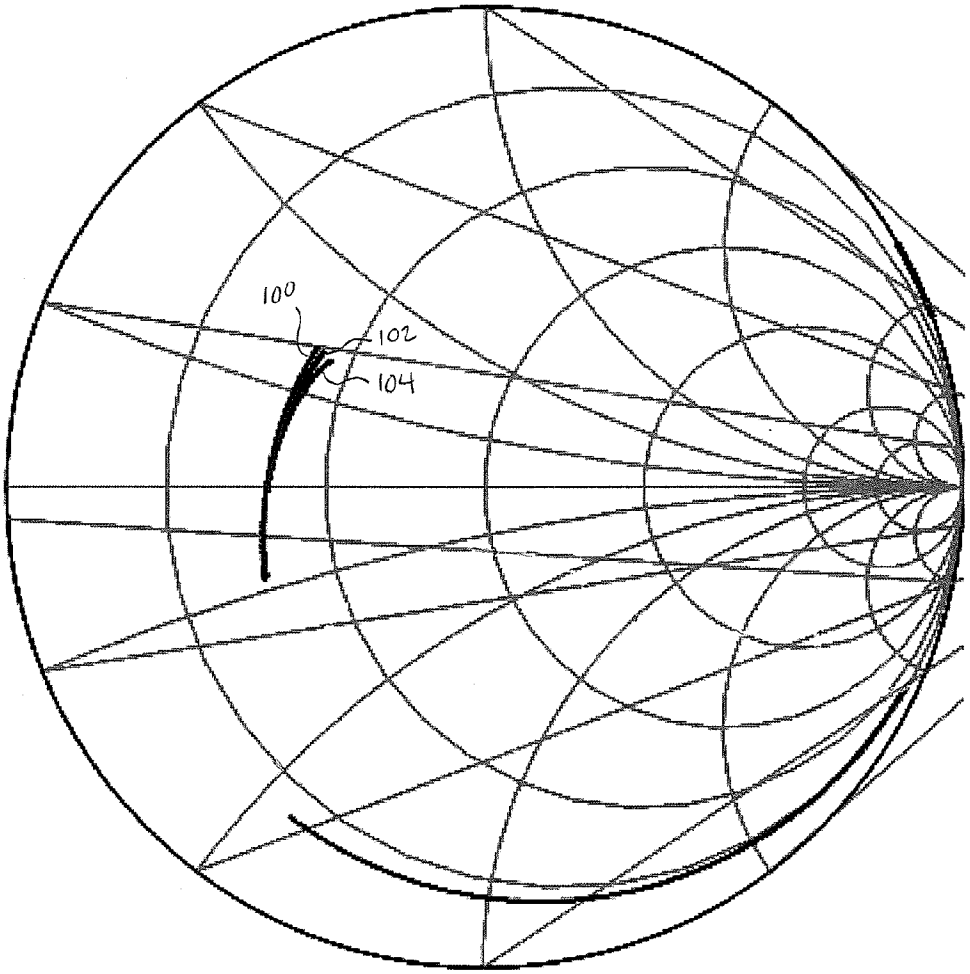
Case: **8824/ETCH/DRIE**
Filed: **April 12, 2004**
Group Art Unit: **1763**

Title: **DUAL FREQUENCY RF MATCH**

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

S I R:

DECLARATION OF STEVEN C. SHANNON UNDER 37 CFR §1.132
EXHIBIT A



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RELATED PROCEEDINGS APPENDIX

[NONE]